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Editorial

Special Issue on HVDC for Grid Services in Electric Power Systems

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1. Introduction

The modern electric power system has evolved into a huge nonlinear complex system, due to the interconnection of a lot of generation and transmission systems. The unparalleled growth of renewable energy resources (RES) has caused significant concern regarding grid stability and power quality, and it is essential to find ways to control such a massive system for effective operation. The controllability of HVDC and FACTs devices allows for improvement in the dynamic behavior and flexibility of grids. Research is being carried out at both the system and component levels of modelling, control, and stability. This Special Issue aims to present novel topologies or operation strategies to prevent abnormal grid conditions. The papers published in this special issue are categorized into several representative themes and briefly summarized the main contents of each paper.

2. Improved HVDC Operation and Control Strategy for System Stability

Analysis of Six Active Power Control Strategies of Interconnected Grids with VSC-HVDC [1]

In this paper, the generator angle stability of several active power control schemes of VSC-based HVDC is evaluated for interconnected two AC systems. Furthermore, in order to effectively evaluate angle stability, the Generators-VSC Interaction Factor index is newly implemented to distinguish the participating generators group which reacts to the converter power change.

A Virtual Impedance Control Strategy for Improving the Stability and Dynamic Performance of VSC–HVDC Operation in Bidirectional Power Flow Mode [2]

This paper adds the control loop to improve the performance and eliminate the steady-state error in the existing virtual impedance control of VSC HVDC. This paper eliminates the steady state with an additional control loop and verifies it by experiment and modeling.

Novel Transient Power Control Schemes for BTB VSCs to Improve Angle Stability [3]

This paper proposes two novel power control strategies to improve the angle stability of generators using a Back-to-Back (BTB) system-based voltage source converter. The power control strategy can emulate the behavior of the ac transmission to improve the angle stability while supporting the ac voltage at the primary level of the control structure.

Development of A Loss Minimization Based Operation Strategy for Embedded BTB VSC HVDC [4]

Using the power transfer distribution factor (PTDF), the HVDC-sensitive AC lines are classified as a monitoring line in advance, and a strategy for determining operating point for normal/emergency conditions is proposed.

3. HVDC Protection Strategy in Contingency Cases

A Novel Overcurrent Suppression Strategy during Reclosing Process of MMC-HVDC [5]

This paper discusses a strategy to control the overcurrent that can occur in the post-fault process of mesh current method (MMC)-HVDC. A MCM is proposed for accurate overcurrent calculation of a loop MMC-HVDC grid, and a reclosing current limiting resistance (RCLR) is calculated using the result.

Assessment of Appropriate MMC Topology Considering DC Fault Handling Performance of Fault Protection Devices [6]

This paper compared DC fault handling performance in variable fault location on a DC line. The simulation result confirmed that Half Bridge-MMC with a hybrid circuit breaker (HCB) is superior than FB-MMC with a residual circuit breaker (RCB) due to low fault current, low interruption time, low overvoltage magnitude and faster recovery.

A Study on Stability Control of Grid Connected DC Distribution System Based on Second Order Generalized Integrator-Frequency Locked Loop (SOGI-FLL) [7]

This paper proposes advanced control method using Second Order Generalized Integrator-Frequency Locked Loop (SOGI-FLL) that can be applied to a 3-phase AC/DC PWM converter for DC distribution. The proposed control scheme improves transient characteristics of DC distribution systems.

4. HVDC Planning & Implementation Strategy, and Field Test Experience

A Frequency–Power Droop Coefficient Determination Method of Mixed Line-Commutated and Voltage-Sourced Converter Multi-Infeed, High-Voltage, Direct Current Systems: An Actual Case Study in Korea [8]

In this paper, a new frequency-power droop coefficient determination method for a mixed line-commutated converter (LCC) and voltage-sourced converter (VSC)-based multi-infeed HVDC (MIDC) system is proposed. An interior-point method is used as an optimization algorithm to implement the proposed scheduling method, and the droop coefficients of the HVDCs are determined graphically using a Monte Carlo sampling method.

Application of a DC Distribution System in Korea: A Case Study of the LVDC Project [9]

This paper demonstrates DC distribution with real field test results. The authors also propose the operating procedures for an insulation monitoring device (IMD) and its algorithm. The real field test result in Gwangju was analyzed and the authors checked real IMD operation procedures.

A Quantitative Index to Evaluate the Commutation Failure Probability of LCC-HVDC with a Synchronous Condenser [10]

An index is proposed to allow quantitative evaluation of the positive effects on the commutation failure probability of LCC HVDC before and after the synchronous condenser is installed. This paper provides a rationale for the capacity allocation of synchronous condensers in LCC HVDC Projects.

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References

1. Song, S.; Yoon, M.; Jang, G. Analysis of Six Active Power Control Strategies of Interconnected Grids with VSC-HVDC. *Appl. Sci.* **2019**, *9*, 183. [CrossRef]

2. Li, Y.; Liu, K.; Liao, X.; Zhu, S.; Huai, Q. A Virtual Impedance Control Strategy for Improving the Stability and Dynamic Performance of VSC–HVDC Operation in Bidirectional Power Flow Mode. *Appl. Sci.* **2019**, *9*, 3184. [CrossRef]
3. Song, S.; Hwang, S.; Ko, B.; Cha, S.; Jang, G. Novel Transient Power Control Schemes for BTB VSCs to Improve Angle Stability. *Appl. Sci.* **2018**, *8*, 1350. [CrossRef]
4. Lee, J.; Yoon, M.; Hwang, S.; Jeong, S.; Jung, S.; Jang, G. Development of A Loss Minimization Based Operation Strategy for Embedded BTB VSC HVDC. *Appl. Sci.* **2019**, *9*, 2234. [CrossRef]
5. Jiang, B.; Gong, Y. A Novel Overcurrent Suppression Strategy during Reclosing Process of MMC-HVDC. *Appl. Sci.* **2019**, *9*, 1737. [CrossRef]
6. Lee, H.-Y.; Asif, M.; Park, K.-H.; Lee, B.-W. Assessment of Appropriate MMC Topology Considering DC Fault Handling Performance of Fault Protection Devices. *Appl. Sci.* **2018**, *8*, 1834. [CrossRef]
7. Kang, J.-W.; Shin, K.-W.; Lee, H.; Kang, K.-M.; Kim, J.; Won, C.-Y. A Study on Stability Control of Grid Connected DC Distribution System Based on Second Order Generalized Integrator-Frequency Locked Loop (SOGI-FLL). *Appl. Sci.* **2018**, *8*, 1387. [CrossRef]
8. Lee, G.; Moon, S.; Hwang, P. A Frequency–Power Droop Coefficient Determination Method of Mixed Line-Commutated and Voltage-Sourced Converter Multi-Infeed, High-Voltage, Direct Current Systems: An Actual Case Study in Korea. *Appl. Sci.* **2019**, *9*, 606. [CrossRef]
9. Kim, J.; Kim, H.; Cho, Y.; Kim, H.; Cho, J. Application of a DC Distribution System in Korea: A Case Study of the LVDC Project. *Appl. Sci.* **2019**, *9*, 1074. [CrossRef]
10. Sha, J.; Guo, C.; Rehman, A.; Zhao, C. A Quantitative Index to Evaluate the Commutation Failure Probability of LCC-HVDC with a Synchronous Condenser. *Appl. Sci.* **2019**, *9*, 925. [CrossRef]